Study on the Opportunities Related to Coastal Vulnerability in Indonesia Using Bibliometric Analysis

Dini Daruati, Unggul Handoko, Meti Yulianti, Iwan Ridwansyah, Aldiano Rahmadya, and Dewi Verawati

Abstract—Coastal areas have very important roles and benefits. Unfortunately, most of them in the world are experiencing the effects of climatic changes such as rising sea levels, increasing coastal erosion, and marine intrusion. Meanwhile, there have been many studies on coastal vulnerability from various aspects and perspectives. Therefore, it is necessary to study the trend on coastal vulnerability from past historical records of several decades ago and also from the aspects that have not been studied. This study aims to identify gaps and opportunities related to coastal vulnerability to provide solutions to sustainability themes in the future. Also, there is a need for this study since it is not monotonous and contains a novel element. The method used in this review article is Web of Science (WoS) as the database source, while VOSviewer is used to visualize and analyze the Bibliometric maps. WoS is a website that provides subscription-based access to multiple databases that provide comprehensive citation data for many different academic disciplines, while VOSviewer is a software tool for constructing and visualizing bibliometric networks. The analysis shows that for over 20 years, topics related to coastal vulnerability around the world are divided into four categories, each of which shows the most frequently occurring themes, namely climate change, coastal vulnerability, sea level, and vulnerability. Subsequently, there is a gap in coastal vulnerability, which is a topic on climate change that has been rarely studied in Indonesia since 2015. This bibliometric approach is used to identify key themes in each study or scope of knowledge that has been conducted so far, which is beneficialin determining novel future research.

Index Terms—Web of science, VOSviewer, coastal sustainability.

I. INTRODUCTION

Coastal areas have a very important roles for human life by providing various ecosystem services of environmental, socio-economic, and cultural values. Coastal areas serve for recreational activities, transportation facilities, military training sites, waste disposal, industrial and manufacturing zones, and habitat for wildlife. The attractiveness of coastal regions has led to a significant population growth, and it is expected to continue in the future, particularly in developing countries [1]. In fact, about 60% of the world's major cities are situated in the coastal zone [2], and 40% of world's population live within 100 km of this zone [3]. Due to its position at the boundary between land and oceans, coastal areas are exposed to high risk of hazard, both caused by natural and anthropogenic factors. Three dominant factors affecting the coast include land, ocean, and atmosphere [4]. An increase in the incidence of natural events (e.g. tsunamis, shoreline erosion, inundation) and human-induced (e.g. contaminations, habitat loss, coastal subsidence) have been observed in coastal regions worldwide [4]-[6]. Furthermore, these threats continuing to put coastal systems under global pressure.

A coastal hazard is defined as a major event that disrupts the functioning of a community or society and results in loss or damage to people, objects, the economy, or the environment [7], [8]. More so, the coastal hazard will have major impact if it occurs in densely populated areaswith high socio-economic activity. On the other hand, thediscussion of hazards is always closely related to vulnerability. Vulnerability is the key to Disaster Risk Management (DRM) which has been discussed from perspectives of various disciplines [9].

One way to reduce the risk of coastal disasters is to learn more about the spatial distribution of disaster impact levels and the vulnerability of coastal communities. Vulnerability is a concept whose meaning varies widely in several books and citations, owing to the lack of a consensus definition [10]. Vulnerability can be defined as the degree of the community to experience harm due to external pressures [11]. Based on [12], it is the degree to which a system is susceptible to injury, damage, or harm from climatic factors. More so, it reveals potential losses in a broader sense, which could focus on the coastal system's environmental and/or community components [13]. Meanwhile, several international research groups have proposed a scientific framework for identifying the coastal sector that is more vulnerable to the effects of sea-level rise and extreme events, based on the development of a vulnerability index [14].

Vulnerability is an important part of hazard that refers to the susceptibility of people, communities, or regions to hazards [15]. Therefore, detailed knowledge of the vulnerability is the essential component needed in mitigating the effects of a wide range potential hazards [16].

Studies on this matter have been carried out in many countries and most of them have been published globally. However, information on coastal vulnerability is still very limited in the Asian region, especially in Indonesia, an archipelagic country. Therefore, it is critical to research this topic to continue addressing the challenges of coastal

communities in dealing with the pressures of global change. Furthermore, the results must apply to coastal planning and must be able to present state-of-the-art trends on time [17]. Consequently, the purpose of this research is to identify gaps and future research opportunities related to coastal vulnerability because it can provide future direction on sustainability themes, is novel and is not monotonous.

The scientific literature on coastal vulnerability studies is extensive and can be viewed from a variety of perspectives. To conduct the current study, it is necessary to understand the development of coastal vulnerability in terms of bibliometric maps, and the study's development from year to year. Other models or frameworks on Vulnerability are Social Vulnerability (Cutter et al, 2000), Double Structure of Vulnerability (Bohle, 2001), BBC Framework (Bogardi and Birkmann 2004), MOVE framework (Birkmann et al, 2013), and Multidimensional Vulnerability Framework (Rana and Routray, 2018).

The bibliometric analysis method is used in this study, which is a useful statistical method for analysing a theme quantitatively. Based on this method, a quantitative assessment was conducted on bibliographic data from scientific texts accessible through a database platform containing a wide range of comprehensive data. Meanwhile, bibliometrics can also assess study quality, identify key areas for improvement, and predict future research directions. Also, it is effectively improves the quality of future studies by providing a variety of valuable datasets, as they will know the direction of hot topics and trends in the future [18]. Consequently, the results are expected to provide helpful information for future studies by identifying trends related to coastal vulnerability globally, especially in Indonesia.

II. METHOD

The primary method in this study was identified using a correlation network. The method used in this review article is Web of Science (WoS) as the database source, while VOS viewer is used to visualizing and analyzing the bibliometric maps. Meanwhile, the WoS collection database was scanned for global articles on coastal vulnerabilities published between 2001 and 2021. A period of 20 years is considered representative for this study. It is the most widely used and reliable database, alongside Scopus. However, WoS has the advantage of compiling scientific publications with the most significant impact [19]. Therefore, WoS is used as the database source in this analysis.

The title's most appropriate keyword is "coastal vulnerability," which is a common global concern that has been extensively researched in various parts of the world. As a result, language will not be a barrier to retrieving concept information from general and review articles. Eligible document information includes year of publication, language, journal, title, author, affiliation, keywords, document type, abstract, and the number of citations exported into *.txt format. The capture date is June 23, 2021. Meanwhile, the VOSviewer (version 1.6.16) is used to visualize and analyze Bibliometric maps based on Co-authorship, Co-occurrence, Citation, Bibliographic coupling, Co-citation, and themes. It is a free computer program that has been developed to create

and view bibliometric maps. Unlike most computer programs used for bibliometric mapping, VOSviewer pays special attention to bibliometric maps' graphical representations, making them easy to interpret [20].

Conversely, The Web of Science (WOS) online database contains nearly all-important papers and includes built-in analytical tools for generating representative figures. WOS search results can also be exported to software for further analysis, such as VOSviewer [21].

III. RESULTS AND DISCUSSION

A. Bibliographic Analysis

In WoS, 192 peer-reviewed journals were found between selected the period (2001-2021). At first glance at distribution of publications by year, there has been a growth trend in studies on coastal vulnerability over the past 20 years with the largest publication recorded in 2019 (Fig. 1). Based on this search, 94.3% of publications were in English, Portuguese (2.1%), Spanish (2.1%), Indonesian (1.0%) and French (0.5%). Geographical visualization of the origin of author's country resulting in 66 countries is shown in Fig. 2. The USA was the most frequent author's country with 19%, followed by United Kingdom (9.5%), Spain (7.6%) and Australia (7.3%).
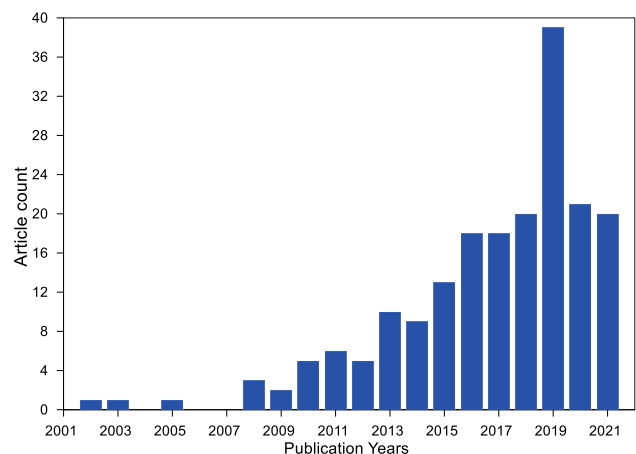

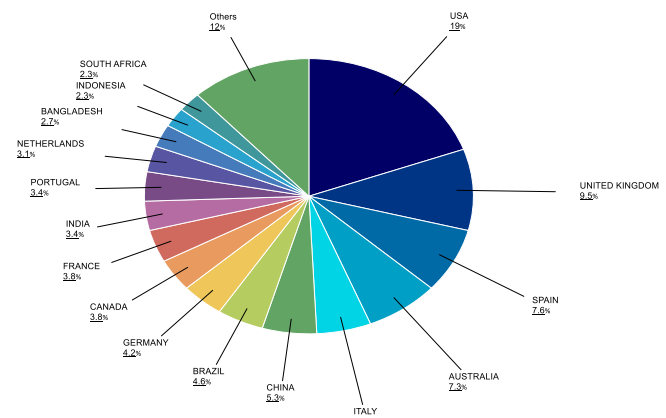Fig. 1. The number of researches on coastal vulnerability by year.

Fig. 2. The number of researches on coastal vulnerability by country.

B. Trends in Topics of the Study-Related to Coastal Vulnerability in the World

Analysis using VOSviewer to identify study topics related

to coastal vulnerability globally for over 20 years reveals four categories, as shown in Fig. 3. Each of the four categories shows the most prominent themes including climate change, coastal vulnerability, sea level and vulnerability, represented in the yellow, red, purple, and green category, respectively. However, only three topics, which are of larger circle sizes, dominate the four categories depicted. These three topics include climate change, coastal vulnerability index, and sea level. Therefore, the larger the size of the circle alongside the size of the letters on each topic, the more significant is the presence of that topic in the title and abstract, which connotes that the size of the letters and circles is determined by the frequency of topics that appear. More so, the more often a topic appears in a keyword, the larger the font and circle size. Consequently, it can be stated that for approximately 20 years, the studies related to coastal vulnerability are mostly related to these most significant topics, which includes climate change, coastal vulnerability index, and sea level.
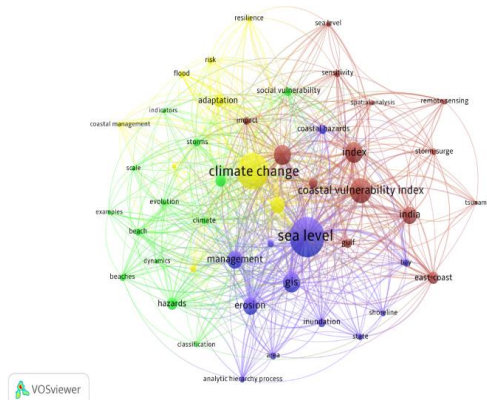

Fig. 3. Visualization of most topics related to coastal vulnerabilities using VOSViewer.

The same colour in the category indicates a close relationship between the topics. As presented in Figure 3, the climate change study will be closely related to studies on the flood, risk, resilience, adaptation, coastal erosion, and coastal management. Also, the sea level study will be closely related to studies on GIS, erosion, management, inundation, analytical hierarchy process, shoreline, area, and coastal hazard. Meanwhile, studies on the Coastal Vulnerability Index (CVI) are closely related to studies of the gulf, index, tsunami, remote sensing, east coast, India, spatial analysis, storm predictions.

Furthermore, Fig. 4a-d show the development trend of each topic over a 20-year period, which depicts the annual trend of topics related to coastal vulnerability.

According to Fig. 4, the trend of topics regarding coastal vulnerability is also related to a rise in sea level. This trend existed between 2001 and 2005, but it was still comparable to other topics, such as elevation, coastal management, vulnerability index, GIS, and others. However, the font size of the sea level rise topic was larger between 2006-2010, 2011-2015-, and 2016–2021-time frames, the latest which has the largest font. This result indicates that study interest in the trend of sea-level rise and coastal vulnerability has risen and fallen over time. More so, this trend may continue to rise in the coming years.
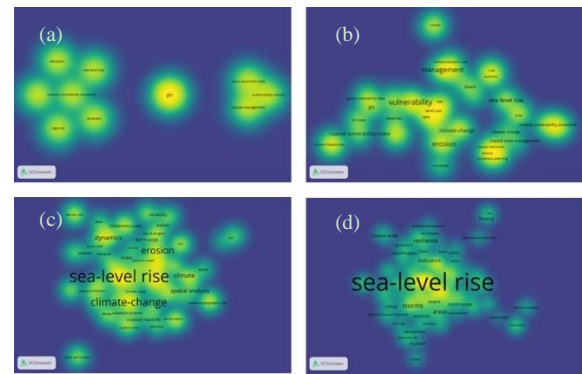

Fig. 4. Visualization of topic trends related to coastal vulnerability from year to year: (a) 2001-2005 (b) 2006-2010 (c) 2011-2015 (d) 2016-2021.

Climate change is also a significant topic in the previous discussion, which is represented in one of the categories, but its study's trend is not visible in Fig. 4 above. Reference [12]-[22]-[23], climate change is caused partially by anthropogenic greenhouse gas emissions and has both short and long-term consequences. Short-term impacts can be seen in variations in the frequency of climate anomalies such as rise in sea level, floods, droughts, heatwaves, and storms, while long-term impacts can be seen in climate variables such as temperature increases. Furthermore, studies on climate change-related coastal vulnerability began in 2006 and reached a peak in 2011-2015. Unfortunately, studies on the topic of climate change no longer existed during 2016-2021, creating this opportunity for future studies to revive this topic related to coastal vulnerability. Meanwhile, climate observations show that extreme events, particularly those related to rainfall and air temperature, have increased in both frequency and intensity [12], [24].

In addition, studies on climate change are critical since it can alter the nature of many protected forests, putting people at greater risk of natural disasters [25]. Furthermore, climate change and global warming are causing a rise in sea level due to ocean expansion caused by melting polar ice. As a result, most of the world's coastlines will experience inundation and increased erosion. Therefore, it is critical to make accurate predictions about the evolution of these threats in the coming years to manage the resulting risks [26]. Another study [27], has stated that climate change topics are important as a driver in improving impact analysis and identifying the main vulnerabilities due to climate change. As a result, they can be used as future adaptation measures

C. Trends in Topics of the Study Related to Coastal Vulnerability in Indonesia As An Archipelagic Country
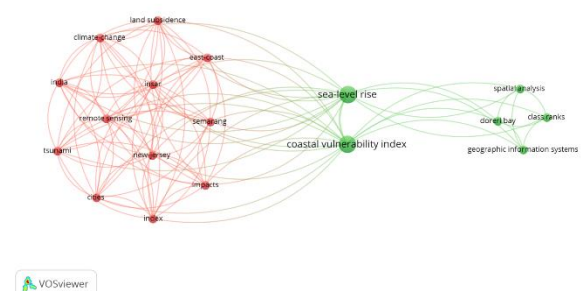

Fig. 5. Topics related to coastal vulnerability with the country filter "Indonesia".

The following bibliometric analysis, which was carried out in Indonesia, is presented to determine the gaps in coastal vulnerability or study locations. Fig. 5 depicts coastal vulnerability topics with the filter "Indonesia."

According to Fig. 5, the topics related to the coastal vulnerability in Indonesia only formed two categories, with the two most important themes being a rise in sea level and coastal vulnerability index. Furthermore, the most globally significant topics are nearly identical to Indonesia's, which are the rise in sea level and coastal vulnerability. However, the difference is that climate change regarding the coastal vulnerability in Indonesia is not or has not become a significant topic, although research has been conducted. However, there is still a great opportunity and need to research this topic in Indonesia

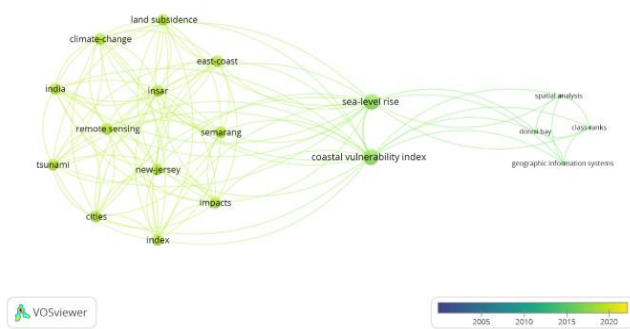Conversely, Fig. 6 shows how to determine the study period related to coastal vulnerability.

Fig. 6. Study-related to coastal vulnerability by year.

According to Figure 6, studies relating to the coastal vulnerability in Indonesia began between 2015 and 2018, which was a short and limited time frame. Also, this study was never conducted in Indonesia during 2020-2021, which was also a short and limited period. Therefore, this situation is quite unfortunate since Indonesia is an archipelagic country with many disasters threatening its coastal areas. In addition, natural disasters such as tectonic earthquakes, tsunamis, hurricanes/hurricanes, floods, volcanoes, and landslides are common in coastal areas and small islands in Indonesia due to geographical and geological conditions, and almost all big cities in Indonesia are coastal areas with a large population and rapid economic activity [28].

Therefore, it is necessary to identify these vulnerable areas on the coast for effective coastal management, including the preparing local area management plans. Reference [29], disasters that may occur in coastal areas include accelerated coastal erosion due to an increase in water level, changes in wave patterns due to sediment transport, alongside permanent inundation and cyclonic storms experienced by low-lying areas, which will increase erosion on the coast and worsen inundation further inland.

The limitations of this study are bibliometric analysis cannot predict future trends, and database in WoS does not contain all research. English language in keyword can give the biased result because maybe there are some local word to describe the coast.

According to the explanation above, studies on climate change relating to coastal vulnerability need to be re-conducted because the topic has become dim in the last five years, even though climate change in the future will be more intense in its occurrence and may cause impacts that are more severe than those experienced today. Furthermore, similar study in Indonesia is still very limited, which opens up a great opportunity to be studied since it can become novel research and enrich the repertoire of study in Indonesia. This study can serve as a baseline for future systematic review and it can be useful in determining novel future research.

IV. CONCLUSION

Using a database from the Web of Science, this study seeks to identify gaps in various topics of study related to coastal vulnerability around the world. According to the bibliometric analysis using VOSviewer visualization, it is possible to conclude that there is a knowledge gap regarding coastal vulnerability, specifically on climate change. Therefore, this bibliometric approach is used to identify key themes in each study or scope of knowledge that has been conducted so far, which is useful in determining novel future research.

CONFLICT OF INTEREST

"The authors declare no conflict of interest".

AUTHOR CONTRIBUTIONS

All of the authors contributed to the various sections of the article. Also, Dini Daruati, Unggul Handoko, and Meti Yulianti were the main contributors, alongside Iwan Ridwansyah, Aldiano Rahmadya, and Dewi Verawati who are members that contributed. Subsequently, the published version of the manuscript has been read and approved by all authors.

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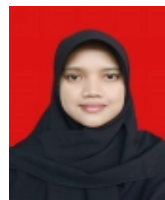
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